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ABSTRACT

A model is presented for the implementation of instructional technology into schools. After a brief definition of instructional technology, its advantages and disadvantages are outlined and factors that contribute to the failure or success of an instructional technology program are highlighted. Each of the following components of the model are then described in detail as they relate to integrating technology into an educational system: planning, support, training, access, resources, monitoring and evaluation. A diagram of the model is presented to illustrate the relationship the components to each other. (Author/AEF)

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Implementing Instructional Technology in Schools

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Abstract

A model is presented for the implementation of instructional technology into schools containing the following components: planning, support, training, access, resources, monitoring and evaluation. Each of the components are described in detail as they relate to integrating technology into an educational system. A diagram of the model is presented to illustrate the relationship of each component to each other. Other issues that are also discussed are definitions for instructional technology, the advantages and disadvantages of using instructional technology in education, and a brief review of factors affecting the success and failure of programs that have introduced technology into school in the past.

Implementing Instructional Technology in Schools

After reading many articles on the implementing of technology programs in schools, a model for the implementation of a technology program slowly formed in my mind. This model will be of help to schools during the continuous process of introducing and using technology. The components of this model are planning, support, training, access, resources, monitoring and evaluation. This model shares some features with a model developed by Leggett and Persichitte (1998), but greatly expands on their model and includes features which were not found in theirs, but are important for the success of an instructional technology program. It is also based on a study by Kao and Wedman (1995) which describes the failure of a technology program in a high school social studies department.

Before a school begins the implementation of an instructional technology program, two things need to be determined. First, the staff of the school, parents, and the community need to determine what is exactly instructional technology for them. Second, they must determine if using technology is the right approach for the goals that they want to achieve. To do this, the advantages and disadvantages of using technology in education must be clearly understood. Once answers have been formed for the aforementioned items, careful planning is needed to insure the success of an instructional technology program. It is hoped that the model presented in this paper can help with the implementation of a technology program, and lead to its success.

Considerations Before Implementing a Technology Program

Defining Instructional Technology

The use of instructional technology in the classroom is becoming very common today. But, what is meant by instructional technology? In the 1950's and 60's instructional technology was film (Leggett & Persichitte, 1998), which has become videotape today. Today the most common definition of instructional technology is that it is "the most advance technology available for teaching and learning in a particular area." (Coley, Cradler, & Engel, 1997, p. 11) To most people this means computers (Brody, 1995), but instructional technology is much more than just computers. According to Coley, Cradler, and Engel (1997) instructional technology includes

computers, multimedia computers, cable TV, Internet access, CD-ROM, networks (LAN and WAN), videodisc, and satellite technology. One of the first things that must decided is what does instructional technology mean for everyone that is involved in the school.

Advantages and Disadvantages of Instructional Technology

Once there has been a decision on what instructional technology means, both the advantages and disadvantages of the use of technology must be understood before making any decision about implementing a program to integrate technology into a school. The following is a list of advantages that have been found for using computers in education.

For Students:

- Increased student motivation (O. Lee, 1997)
- Students have access to resources and expertise (Coley, Cradler, & Engel, 1997; Mergendoller, 1997)
- Improve communication between students (Heide & Henderson, 1994)
- Experiences with technology of the adult working world (Dede, 1998; Heide & Henderson, 1994; Coley, Cradler, & Engel, 1997)
- Develop skills in cooperation, communication, and problem solving (Dede, 1998; Heide & Henderson, 1994; Coley, Cradler, & Engel, 1997; Mergendoller, 1997)
- Improved student performance (Brogan, 1999; Dede, 1998; Heide & Henderson, 1994; Mann & Shafer, 1997; Coley, Cradler, & Engel, 1997; Mergendoller, 1997)
- Students like classes that use computers (Heide & Henderson, 1994; Coley, Cradler, & Engel, 1997)
- More positive attitude towards computers (Heide & Henderson, 1994; Coley, Cradler, & Engel, 1997)
- Improved student writing (Heide & Henderson, 1994; Coley, Cradler, & Engel, 1997)
- Increased time on task (Dede, 1998)
- Independent learning—Students are more responsible for their own learning (Heide & Henderson, 1994; McDonald & Ingvarson, 1997)
- Students master advance topics (Dede, 1998)
- Students acting as experts do (Dede, 1998)

For Teachers:

- Increased teacher satisfaction (Coley, Cradler, & Engel, 1997)
- Increased teacher productivity (Heide & Henderson, 1994)
- Helps teachers with the diversity of students they must instruct (Mergendoller, 1997; Newton, 1997)
- Makes teaching more exciting (Dede, 1998)
- Keeps teachers involved with the students (Dede, 1998; Newton, 1997)
- By using computers, teachers can access different learning styles (Mergendoller, 1997; Heide & Henderson, 1994; Newton, 1997)
- Teachers have access to resources and expertise (Coley, Cradler, & Engel, 1997)

The advantages of using technology does not automatically flow from the computer or an Internet connection (Meltzer & Sherman, 1998). They are just tools and offer no advantages in of themselves (Coley, Cradler, & Engel, 1997). What is important is how the tools are used.

Teaching methods and strategies used to integrated technology into the classroom are much more important than the use of the technology itself (Brogan, 1999; Heide & Henderson, 1994). The use of technology does have many advantages but there are also some serious disadvantages.

The advantages for the use of instructional technology must be carefully weighted against the disadvantages before a wise decision can be made about implementing a technology program. One major disadvantage of technology is that it is expensive (Brogan, 1999; Mann & Shafer, 1997). Because of limited school budgets, tradeoffs have to be made (Brody, 1995). The purchase of technology and training cost may deprive other necessary programs of funds that are needed by them to accomplish their goals (Becker & Ravitz, 1998). Also, funding may not be available to completely fund a technology program in a school, and difficult choices will have to be made (Mann & Shafer, 1997). A second disadvantage of technology is that it may replace better educational methods, like hands-on-learning or role-playing (Lookatch, 1997). Using technology may also lessen the time available for instruction during a class period (Heide & Henderson, 1994). It takes time to turn on the computer, start the program, save the document, and shut down the computer. This can rob valuable time from instruction. But Newton (1997) points out that computers can save instructional time, because computers are much faster at processing data in science classes than having the students do it by hand. Students can also waste time searching the Internet for the right piece of information (Mergendoller, 1997), when it can be found faster in a library. Again, it is how the computer is used that is important. Finally, it is very difficult to find conclusive evidence for many of the advantages for the use of technology in education.

There is much controversy over whether instructional technology does improve student achievement. Lookatch (1997) says that there is no evidence for computers or any other technology being able improve student achievement, and that most studies that indicate an improvement in achievement have fundamental flaws. At the same time, Man and Shafer (1997) present a study that does point to improvement in standardized test scores and an increase in the number of students going to college after graduating from high school, when computers are used in schools. But even they admit that their study was limited because there was no control, the

withholding of technology from students, and that with a limited budget they could not complete all aspects of their study. Still, most authors (e.g., Dede, 1998; Heide & Henderson, 1994; Mergendoller, 1997) do feel that technology does improve student performance in the classroom and enhances their scores on achievement tests.

Academic achievement is only one of the factors that must be weighed when making decisions about introducing an instructional technology program into a school. Both the advantages and disadvantages need to be carefully considered before making decisions about integrating instructional technology into the school's curriculum. If it is decided that a school should implement an instructional technology program, programs that have either failed or succeeded in the past should be studied, and a model for the implementation of technology into a school should to be used as a guide for the implementation process.

Causes for the Failure or Success of an Instructional Technology Program

Very few innovations that use technology seem to succeed when first introduced into a school. Heide and Henderson (1994) state that "... in fact, the way teachers teach has changed little since the days of the one-room schoolhouse. We tend to teach the way we were taught." (p. 9) This resistance to change can cause an instructional technology program to fail. For a program to succeed, support is needed from both the administration and faculty (Butzin, 1997; Newton, 1997). Besides giving support for a technology program, teachers need confidence and expertise with the technology (Newton, 1997). If teacher support, confidence, and expertise are lacking an instructional technology program is doomed to failure.

Other factors that can cause a program to fail are the lack of time, access, resources, and training (Leggett & Persichitte, 1998; Heide & Henderson, 1994). Training helps to develop expertise with both the technology and the methods for integration of technology into the classroom. Without training, expertise can not be developed and the instructional technology program fails (Newton, 1997). Time is needed so that teachers can learn how to use the technology and how to integrate it into the classroom (Leggett & Persichitte, 1998). Both teachers and students need access to technology for a program succeed (Leggett & Persichitte, 1998; O.

Lee, 1997). Without access, how can the technology be used? Finally, and most importantly, a wise investment in resources is needed (Dede, 1998). Some of the resources needed for an instructional technology program to succeed include computers, money (O. Lee, 1997), and information. If any of the above factors are missing, the program will most likely fail.

One last thing that can cause an instructional technology program to fail is an attitude that technology must be acquired just for the sake of having technology (Becker & Ravitz, 1998). Computers are just tools that will help teachers and students, but they do not do the instruction (Meltzer & Sherman, 1998). By themselves, computers do very little to help students learn (Coley, Cradler, & Engel, 1997). It is how the instructor and students use computers that is important, not the technology itself. When schools acquire technology just to have it, it is a waste of valuable resources (Coley, Cradler, & Engel, 1997). Technology needs to be integrated into the curriculum, and there has to be reasons for the technology's use that can not be easily addressed in other ways (Newton, 1997).

A Model for Implementing Technology into a School

From studying the failures and successes of programs that sought to integrate technology into education, a model can be developed that can help to guide the implementation and integration process. The model that I have developed has seven steps: Planning, Support, Training, Access, Resources, Monitoring, and Evaluation. It is hoped that by following the recommendations that are provided in this paper more instructional technology programs will succeed. The following sections provide details for each of the components of the model, and briefly discusses how each component influences an instructional technology program.

Planning

An instructional technology program needs to be integrated in a systematic way with the existing philosophy, aims, goals and objectives of the school (Niess & Merickel, 1997; McDonald & Ingvarson, 1997). The philosophy, aims, goals and objectives of the school must be used as a guide for the selection of a vision, goals and objectives for the technology program. First a clear vision needs to be established for the instructional technology program. This vision will help to

establish the need for an instructional technology program and help to identify priorities (Meltzer & Sherman, 1998). The main focus for the vision for a technology program should be on how the students will use technology to improve their education (Heide & Henderson, 1994). From this vision, goals and objectives need to be developed for the program. These goals and objectives will help to integrate technology into the curriculum and classroom (Heide & Henderson, 1994). The development of a vision, goals and objectives can be a long and tiring process (Fulton, 1997), but it greatly increases the chance of an instructional technology program's success (McDonald & Ingvarson, 1997).

The plan, for the implementation of a technology program, should help to create a clearer vision of where the program is going, how it is to get there, why the program should be done, who is needed for the success of the program, and finally, what is needed for the program to succeed (Fulton, 1997). At the same time, the plan must be flexible and easy to understand (Fulton, 1997). This plan also needs the broad support of teachers, administrators, students, parents, businesses, and the community to succeed (Heide & Henderson, 1994; Fulton, 1997; Coley, Cradler, & Engel, 1997). Because the need for instructional technology is different from school to school, each school needs to develop an individualized plan for the implementation of an instructional technology program (Mann & Shafer, 1997; O. Lee, 1998). The planing process should be used to help build support for the technology program as the plan for the program is developed.

The Planning Process. To create a plan for the implementation of an instructional technology program, a steering committee and an advisory committee need to be formed. Also, a needs assessment must be done to help with the planning process. A side benefit of technology is that it gets people involved with their school because of the planning process (Fulton, 1997).

One way to encourage the community to support a technology program is to create an advisory committee (Brody, 1995). This committee should be composed of teachers, administrators, students, parents, community members, and other stakeholders in the program (Roberts, 1998; Brody, 1995; Heide & Henderson, 1994). This advisory committee can provide

insights, which can be used to solve problems and resources for the program (Brody, 1995). At the same time, the advisory committee is a way to educate the members and community about the capabilities and limitations of technology, so that informed decisions can be made (Leggett & Persichitte, 1998). An advisory committee is a necessary component to the planning process, especially if a program may result in far reaching changes to the school.

An advisory committee is an important part of the planning process, but according to Brody (1995) a steering committee is also needed. The steering committee is a smaller committee that is usually composed of members from the advisory committee. The members of this committee need to be people that have the power to carry through decisions once they are made (Brody, 1995). For a school, the principal, teachers, and influential community or business members should be members of the steering committee. This committee receives ideas and information from the advisory committee, and uses the advisory committee as a sounding board for their ideas and plans (Brody, 1995). But, almost all of the important decisions are made or approved by the steering committee (Brody, 1995). As both committees form, a needs assessment should be done.

A needs assessment is necessary so that a starting point can be established for the technology program, and effort and time are not wasted (O. Lee, 1998; Kao & Wedman, 1995). The needs assessment for teachers should include information on what they already know, current technology skills, and their comfort level with technology (Fulton, 1997). Students also need to be part of the needs assessment. They need to be asked them what they want from the use of instructional technology in their education (Roberts, 1998). While doing a needs assessment, do not forget to look at the currently available equipment and facilities (O. Lee, 1998). Finally, the assessment process needs to consider the current and long range curricular needs of the school (Roberts, 1998). If there is no curricular need for the use of instructional technology, there is really no reason to implement the program (Kao & Wedman, 1995).

Other Considerations for the Planning Process. Besides the information discovered in the needs assessment, other factors must be considered when developing a plan to implement an instructional technology program. The cost of the program needs to be carefully considered.

Remember technology programs require continual funding (Roberts, 1998). Besides the initial cost of the program, the auxiliary costs and continuing costs need to be calculated (Leggett & Persichitte, 1998). Auxiliary costs include the cost of selecting and evaluating software and coordination of access and integration of the technology. Continuing costs include the cost of maintenance and consumable supplies (Leggett & Persichitte, 1998). Because of the high cost of many technology programs, a balance must be met with other needs of the school, students, and curriculum (Newton, 1997). In this balance, usually technology must give way to the other program needs (Becker & Ravitz, 1998).

In addition to the funds needed by the technology program, how it will be integrated into the curriculum of a school needs to be carefully considered. Technology has usually been viewed as an add-on to the regular curriculum (Heide & Henderson, 1994), but for a technology program to be truly a part of education it must be integrated into the curriculum (Kay, 1997). The planning process must consider how technology will be used in instruction, how it will improve current instructional methods, and how teachers will be trained for integrating technology into their daily lesson plans (McDaniel & Umekubo, 1997). It is crucial that technology be integrated into the curriculum if it is to succeed.

The planning component of this model is just the beginning of a continuous process in the introduction of technology into a school. Planning does not end once the plan is created. The committees must continue to monitor the program and make changes new needs arise. The planning process can be used to build support for a technology program as people meet to work on the different stage in the implementation of a technology program.

Support

Support for an instructional technology program is crucial if the program is to succeed (Leggett & Persichitte, 1998). Continuous support is needed through out all stages of the program, and it does not stop once the plans have been completed. As with planning, all stakeholders have to be involved. This means that the principal, other administrators, parents, community, teachers, and students are needed for success (Coley, Cradler, & Engel, 1997).

Communication, cooperation, and collaboration are necessary between all parties involved in an instructional technology program (McDaniel & Umekubo, 1997). Also the different parties involved in the technology program can provide support for each other and place pressure on each other to keep a program moving forward (Leggett & Persichitte, 1998).

The support of administrators and teachers is of crucial importance in the implementation of a technology program. Administrators provide leadership, act as role models, usually are the major change agents in schools, and they provide the needed resources for the program (Leggett & Persichitte, 1998; Schulz-Hamsa, 1998; Meltzer & Sherman, 1998). The principal, being the chief administrator, "must be 100 percent behind the push to integrate technology into the classrooms." (Fischer, Eisenhaur, et. al., 1998, p. 2) If the principle does not give 100 percent support, the lower emphasis by the principal will mean that a project will have less of a chance of being accepted by teachers (Kao & Wedman, 1995). The principal needs to take the lead in introducing technology into a school (Meltzer & Sherman, 1998), accepting responsibility for the changes the technology may cause (Schulz-Hamsa, 1998), providing necessary training for all employees of the school, and encouraging everyone to take the first steps necessary for implementing a technology program (McDonald & Ingvarson, 1997). But the principal and other administrators can not make a technology program succeed by themselves; they also need the support of the teachers.

If teachers do not support a program, not just an instructional technology program, that program has very little chance of succeeding. Teachers, along with administrators, need to be the driving force behind a program (Roberts, 1998; McDonald & Ingvarson, 1997; Kao & Wedman, 1995). The biggest problem in gaining teacher support is the lack of awareness about the benefits of a technology program (Newton, 1997). To increase awareness, the teachers that will be directly involved in the project should be involved in the planning process. This will help to develop a core of enthusiastic teachers that will be the driving force behind a program (Leggett & Persichitte, 1998; McDonald & Ingvarson, 1997). To create this core of teachers, they need to understand the project (Leggett & Persichitte, 1998), have had success with technology in the past, and are

comfortable with technology (Kao & Wedman, 1995). Teachers provide the foundation on which an instructional technology program is built.

Kao and Wedman (1995) found that support is needed both at the top, from the administration, and at the bottom, from the teachers, for a technology program to succeed. A top-down only implementation of a project will not have the commitment or interest of the teachers, and will most likely fail. A bottom-up only implementation may succeed, but it will usually be small-sale and usually will not go beyond the classroom or school were it was initiated. Both the administration and teachers must be involved and provide support for a program's success (Niess & Merickel, 1997).

To ensure the success of an instructional technology program, support is also needed from parents, the community, and the government. Parents need to be involved in almost every educational program because of their strong influence on the educational performance of their children (Fischer, Eisenhaur, et. al., 1998). The parents need to be kept informed about the instructional technology program, be part of planning process, and be given opportunities to learn more about the program (Heide & Henderson, 1994). Remember, it is the parents and other members of the community that support the school with their tax dollars. The school needs their support, especially when they need to raise funds to buy expensive equipment (Franco, 1997) Partnerships with the business community should also be developed (Heide & Henderson, 1994). The business community can provide jobs for graduating students, support tutor programs for students and staff, help to develop curriculum materials, and donate equipment (Heide & Henderson, 1994). Along with businesses, the state and federal governments can provide support in the form of grants, curriculum materials, and sometimes training (Coley, Cradler, & Engel, 1997). Support from all stakeholders in an instructional technology program is necessary for its success.

Training

For an instructional technology program to succeed, training is needed (O. Lee, 1998). Everyone that is directly involved in the program needs to be trained in both the use of the

technology and how to integrate it into the daily life of the school. Staff, teachers, and administrators need to be provided training (Roberts, 1998). Administrators need training so that they can understand the role that technology will have in their school (Mann & Shafer, 1997) and to act as roll models for others at the school (Leggett & Persichitte, 1998). Training is also another way to build support when implementing a technology program (Coley, Cradler, & Engel, 1997; McDonald & Ingvarson, 1997).

Training is especially important for teachers, since they are the ones that must use the technology and integrate it into the curriculum. Many teachers are reluctant to use technology because they are not familiar with it (McDonald & Ingvarson, 1997) and lack confidence in the use of it (K. Lee, 1997). Training will help to make teachers familiar with technology and build their confidence. While teachers are learning the technology, they also need to receive training in how to integrate technology into their daily lessons (K. Lee, 1997; Coley, Cradler, & Engel, 1997). Learning how to integrate technology into the curriculum is much more important than learning about the technology itself (Coley, Cradler, & Engel, 1997). Training needs to be focused and situational to ensure that technology will be used in the classroom (Meltzer & Sherman, 1998). If a teacher does not know how to use technology to provide meaningful instruction, the equipment will sit idle, gathering dust (Heide & Henderson, 1994; Lambeth, 1998). Even teachers who currently use technology in their classrooms need training because of how rapidly technology and the needs of society change today (Roberts, 1998). Training also needs to be individualized, so that the individual needs and learning styles of the teachers are met (K. Lee, 1997).

Requirements for a Successful Technology Training Program. Most researchers (e.g. McDaniel & Umekubo, 1997; Mergendoller, 1997; Coley, Cradler, & Engel, 1997; Leggett & Persichitte, 1998) agree that the best method for training teachers in instructional technology is by the use of mentors. Using mentors can provide individualization and personalized support for the teachers who are being trained. When using mentors, it is important that the mentors are able to answer questions about integrating technology into the classroom and can model different methods for integration (Meltzer & Sherman, 1998). Another advantage of using mentors is that they will

be available outside of the training sessions to provide support, solutions to problems and needed information (Heide & Henderson, 1994). Mentors can provide continuous staff development throughout the school year.

Training sessions need to be scheduled through out the year so that training will be continuous (Niess & Merickel, 1997; Meltzer & Sherman, 1998). Before a technology program is introduced into a school, a training session, up to six weeks long, is needed to train mentors in the use of the technology, methods for the integration of technology into the curriculum (Niess & Merickel, 1997), and staff development techniques (McDaniel & Umekubo, 1997). Once the mentors have been trained, they can provide regular continuous training for the rest of the school's staff (McDaniel & Umekubo, 1997; Niess & Merickel, 1997). The mentors also need to have regular training sessions throughout the school year so they can improve their skills and discuss problems (Niess & Merickel, 1997). Training sessions for both staff and mentors should provide time for discussion and review of attempts at implementing technology into a classroom (Meltzer & Sherman, 1998), for the practice of skills, and to communicate among peers (Coley, Cradler, & Engel, 1997). Of course, to be able to attend training, teachers, administrators, and staff will require release time (Coley, Cradler, & Engel, 1997).

Two important resources needed for training are time and money. Teachers need time to explore and to learn how to use the technology. Mergendoller (1997) reports that fifth grade teachers in Utah needed 36 hours of training to learn how to use technology in the classroom. On the average, teachers spent 60 percent of the 36 hours learning by themselves, 17 percent of it consulting with colleagues, and 13 percent, of the total time, in in-service training. Most teachers spend at least three times the amount of time that they spend in training learning how to use and integrate technology in their classrooms on their own time (Mann & Shafer, 1997). Time needs to be to teachers so that they can learn how to use technology to improve the education of their students.

The availability of funds can also place a limitation on training. In business, about one-third of each dollar, set aside for technology, is spent on training (Mann & Shafer, 1997). In 1995, 55

school districts in New York State, which had formed a consortium to introduce technology into the classroom, spent only ten cents for every dollar marked for technology on training (Mann & Shafer, 1997). This level of funding for training is too low, and can greatly influence a program's success. Meltzer and Sherman (1998) found that when school districts spend one-quarter to one-half of their technology budget on staff development student use of computers increased and learning was enhanced. Before introducing technology into a school, careful consideration needs to be given to the amount of time and money that will be needed for effective staff training.

Changes in Instructional Strategies. To use instructional technology effectively, teachers may have to change the instructional strategies that they use in their classrooms (Heide & Henderson, 1994; Niess & Merickel, 1997). Technology offers teachers new strategies that can increase the variety of instructional methods used by them. Whole class instruction can easily be combined with individualized and cooperative learning. A mixture of instruction methods will produce the best results for student learning and achievement (Heide & Henderson, 1994; Oliva, 1997). What changes technology will cause in a teacher's instructional strategies depends a great deal on the individual teacher and will vary from teacher to teacher (Newton, 1997). As stated earlier, teachers usually use the methods that they were taught with and it is hard for them to change their methods, but with time and practice it is possible to change. It must be remembered that it not the curriculum that changes, but the instructional strategies that change (Fischer, Eisenhaur, et. al., 1998; Niess & Merickel, 1997). This is why it is important to have a strong curriculum before technology is introduced into a school (Heide & Henderson, 1994).

Computers encourage a learner-centered classroom, where the instructor is a facilitator of learning (Levine & Donitsa-Schmidt, 1995; Meltzer & Sherman, 1998). Teachers are free to focus on each student's needs and to provide help to individual students as they need it (McDonald & Ingvarson, 1997). Students, with computers, will be able pursue topics that interest them as they explore the world through the use of technology (McDonald & Ingvarson, 1997). Teachers need to instruct students in how to be responsible for their own learning and to provide a way so that both the teacher and students can track progress (Heide & Henderson, 1994; Butzin, 1997).

Since technology is expensive, teachers may have a limited number of computers in their classrooms. Because of the limited number of computers, several activities may have to occur at the same time in a classroom when the computers are being used by the students (Newton, 1997). The teacher will have to use cooperative learning groups so that each group will be able to work independently on the varying activities (Clark, 1998). These learning groups can provide support for learners of different abilities if they contain a heterogeneous mixture of students with different abilities. When teachers receive training for an instructional technology program, training is needed in three areas: (1) how to use the technology, (2) how to integrate technology into the curriculum, and (3) practice with the instructional strategies that use technology in the classroom (Coley, Cradler, & Engel, 1997).

Access

If tools, materials, and training are provided, but no one can use them, nothing will be built. This is also true for an instructional technology program. The staff of a school can be trained and equipment can be provided, but if there is no access the program will fail (Heide & Henderson, 1994; Meltzer & Sherman, 1998). As Meltzer and Sherman (1998) state, "Because equipment is new and expensive, some principals are inclined to keep it locked up. But technology is a tool that requires practice to be used well." (p. 3) O. Lee (1998) reported that more than 50 percent of teachers and students surveyed in Korea, where the government has instituted a strong educational technology program, said that they had limited access to multimedia computers, and that this was a major barrier in their use of computer technology. The same survey noted that 23 percent of the students did not have access to computers at all. One has to wonder what access students in the United States have, where technology is not as well integrated into the schools as it is in Korea. Both teachers and students need access to the technology if a program is to succeed.

Teachers. Teachers need access to computers to practice new skills, experiment, and discover ways to integrate technology into the curriculum (Meltzer & Sherman, 1998; O. Lee, 1998). Teachers need unlimited access to computers if technology is to be used effectively in education. Every classroom needs at least one computer in it, if not more, so that teachers and

students can have access to the technology when they need it (O. Lee, 1998; McDaniel & Umekubo, 1997). Teachers also should be allowed to borrow equipment for use at home when school is not in session (Meltzer & Sherman, 1998). When a teacher has unlimited access to technology, the teacher becomes more skillful in the use of technology (Mann & Shafer, 1997) and encourage its use among his or her students (K. Lee, 1997).

Students. Students also need access to technology. If they do not have access to instructional technology, than why have it in the school? Five issues have been raised concerning student access to technology: ability level, social-economic level, ethnicity, gender, and students with disabilities.

The biggest stumbling block to student access to technology is the practice of *tracking* in education. Tracking is the practice of dividing students into groups for instruction based on past grades or results from some standardized test. In a study conducted by Becker and Ravitz (1998), it was found that students in the low-ability groups rarely, if ever, used computers. Teachers with advance students were usually more willing to experiment and use innovations in the classroom. With lower-ability students, teachers used more traditional methods of instruction in the hope that these methods would increase student test scores (Becker & Ravitz, 1998). Also, advance students may be offered the use of computers or the Internet as a reward, which is not available to other students (Becker & Ravitz, 1998).

While Becker and Ravitz (1998) found a different in computer usage by student ability grouping, they did not find any major differences when ethnicity or social-economic level were considered. It is true that students from more affluent homes have more access to technology, especially at home, but at school, there seems to be little or no difference in computer access between students of different social-economic levels (Dede, 1998). In the early years of computer use, there was a difference, but this difference is diminishing today because of the drop in the prices of computers (Becker & Ravitz, 1998; Dede, 1998). Owens and Waxman (1998) also found that African American students were using computers more often than Hispanic or white students in science and mathematics. Teachers need to be aware that student access to educational

technology may be influenced by the ethnicity or social-economic level of students, but their influence on access does not seem to be large at most schools.

Gender differences do seem to be an issue when technology is introduced into a classroom. Female students view computers as tools used to get a job done, while male students are more interested in the technology itself (Levine & Donitsa-Schmidt, 1995). Female students also are more likely to have more experience with word processing than male students (Levine & Donitsa-Schmidt, 1995; K. Lee, 1997). In mathematics and science, male students use computers more often than female students (Owens & Waxman, 1998). From my own experience as a computer science instructor at a small rural high school for the pass nine years, I have seen no real difference in computer usage based on gender in my basic computer classes. In my advance computer class, female students out number male students by three to one, which would indicate that female students are more likely to use computers. A teacher does need to be aware that there are differences in how male and female students perceive technology, and not allow one group to monopolize the use of the technology.

Finally, access by students with learning disabilities needs to be considered when instructional technology is used in a classroom. To accommodate students with learning disabilities, the location, furniture, or technology may have to be modified (Heide & Henderson, 1994). More space may be needed for a student in a wheelchair so that he or she can reach the computer, or a computer located in cubical may be needed for highly distractible students (Heide & Henderson, 1994). Also students with learning disabilities may need special assistive technology to use computers in the classroom, for example, special keyboards, switches, screen magnifiers, or other devices (Brett, 1997). Because of the *Americans with Disabilities Act*, special effort needs to be made to make sure that students with learning disabilities have equal and fair access to instructional technology.

Access to technology is very important if an instructional technology program is to succeed. Teachers need access to learn how to use and integrate technology into their classrooms. Students also need access, because the reason for using instructional technology in the first place is to

improve the education of the students. Obviously, if students do not have access to the technology, money, time and effort have been wasted by introducing technology that is not used. But the issue of student access goes beyond just having students use the technology. Because we live in a democratic society, students need to have fair and equal access to technology. This is why issues of ability level, social-economic level, ethnicity, gender, and students with disabilities were raised in this paper. These issues always need to be considered when any changes are made in a school.

Resources

When one thinks of resources for instructional technology, money and equipment are the first things to come to the mind, but resources are much more than money and equipment. Some of the other resources that are needed for an instructional technology program are time, infrastructure, communications, and support. Because money is usually considered the most important resource needed for a technology program, it will be discussed first.

Fiscal Resources. An instructional technology program is expensive. A computer lab in a school averages $125,000 per lab. If computers are placed in the classroom the cost averages $555,000 for five computers in each class per school. This is $225 to $965 per student (Coley, Cradler, & Engel, 1997). This is just the initial cost of buying and installing the technology. Besides budgeting for the equipment and installation, funding is also needed for staff development, technical support, maintenance, upgrading hardware and software, physically and electrically reconfiguring the classrooms, phone bills and on-line accounts (Leggett & Persichitte, 1998). Also, money needs to be budgeted so that old equipment can be replaced as it out grows its usefulness (Meltzer & Sherman, 1998). As part of the planning process, fiscal resources need to be identified for all aspects of an instructional technology program.

Identifying funds for technology needs to be part of the regular budgeting process for all schools. There should be a line in the school's budget for technology, as there is for salaries and textbooks (Roberts, 1998). Because of the large expense of instructional technology, purchases should be spread over a period of time, one small step at a time (Lambeth, 1998). These small

steps can help to create a new instructional technology program or support one that is already in existence. At least a modest commitment must be made to technology in the school's budget. Another way to finance purchases is to set aside money in a technology reserve fund so that large purchased can be made in the future (Roberts, 1998). When there is not enough money available in a school's budget, to finance an instructional technology program, other sources of funding need to be explored.

Schools must explore all means to raise or save money so that instructional technology can be successful implemented in a school. Mann and Shafer (1997) asked teachers if they would be willing to have larger class sizes if they could have more technology and a pay raise. Almost all of the teachers surveyed said yes. This could add about $37,500 to the budget for every five students added to a teacher's class. If funds can not be raised in any other way, parents may have to accept a tax or tuition increase so that their children can have the use technology at their school (Roberts, 1998). This is why it is important to have the support of parents when an instructional technology program is being implemented in a school.

If funds are not available, schools will have to find ways to save money. Schools can achieve cost reductions for Internet service by carefully planning the network's configuration, asking for discounted group rates or the donation of services, and looking for special programs provided by businesses or the government (Coley, Cradler, & Engel, 1997). Using old equipment is also an option, until more funding can be acquired (Newton, 1997). The school needs to survey its existing inventory, to locate equipment that is currently not being used or is being under used, and find a place for it with a teacher that can use it (Heide & Henderson, 1994). Because of the wide range in ages of computers that a school may have, older software should be considered for purchase, so that it can be used on the maximum range of computers (Brogan, 1999). Also older software is usually a lot lower in price than the latest version. A school can also look to the local business community for help, both financially and with equipment donations.

Forming partnerships between schools and businesses can benefit both. A business can provide leadership, advice, financial assistance, equipment, and equipment support and services to

the school (Heide & Henderson, 1994). The business receives trained future employees and publicity when a partnership is formed with a school (Heide & Henderson, 1994). In Korea, business are encouraged to form partnerships with schools by the national government, which gives the business an exclusive right to provide services to the school that it forms a partnership with (O. Lee, 1998). A partnership between a school and business needs to be a long-term relationship, which involves planning and cooperation by both parties (Heide & Henderson, 1994).

Another source of funding to be considered are grants from non-profit organizations (Franco, 1997), state governments, and the federal government. To help in receiving these grants, staff members should be given release time to attend grant writing workshops (Lambeth, 1998). The time and money that is invested in an employee who attends a grant writing workshop will be returned many times over if he or she is able to obtain just one grant. There are many grants available that are created just to encourage the use of technology in education (McDaniel & Umekubo, 1997), but a technology program should not be financed by grants alone. What will happen to the program once the grant money runs out? This is why a line for technology, no matter how modest, must be included in the school's budget.

Time. Another resource needed for the successful implementation of an instruction technology program is time. The lack of time can be one of the largest barriers to the introduction of technology in education (Meltzer & Sherman, 1998). Both Leggett and Persichitte (1998) and Meltzer and Sherman (1998) report that teachers need time to accomplish the following tasks. Time is needed by teachers for planning and preparing for the use of technology in the classroom. Teachers need time to explore and experiment with technology. Time must also be found for training, both during and outside the school day. Finally, teachers need time to talk with their peers about their experiences and the problems that they have experienced with technology. Without time to collaborate, learn, and develop skills, teachers have little chance of taking advantage of what technology can offer to education (Kao & Wedman, 1995).

Time must also be built into the school day so that students have time to use the technology. One of the major constrains on time, in most schools, is the 50 to 55 minute instructional period (Kao & Wedman, 1995). Students need time for open-ended learning (Kao & Wedman, 1995), small-group learning, and individualized activities (Heide & Henderson, 1994). When students are using technology the time needs to be free from interruptions (Butzin, 1997; Heide & Henderson, 1994; Kao & Wedman, 1995). In elementary schools, teachers have much more freedom to explore the use of new instructional methods, because less emphasis is placed on subject periods, unlike high schools. Having less emphasis on set time periods may be one of the reasons why the use of technology is more common in elementary schools (Niess & Merickel, 1997).

An elementary school teacher is not as tired into meeting the standards imposed by states, colleges, or standardized tests (Niess & Merickel, 1997). A strong emphasis on academic achievement at a school may discourage teachers from taking the time to explore instructional methods that use technology. Teachers are pressured to make sure that their students learn the facts so that they can pass the required tests (Kao & Wedman, 1995). When technology is introduced into a school, a move has to be made away from just using standardized testing to measure achievement of students, or these tests need to be changed so that they measure the skills and knowledge that the use of technology develops (Coley, Cradler, & Engel, 1997). Until achievement tests are modified, they will place demands on how time is used in a class and will lessen the chance of students using technology to enrich their education.

Infrastructure. The infrastructure of the school must be able to support the instructional technology that will be installed. When building a new school or classroom, it should be designed to allow for expansion and changes so that future technology needs can be accommodated (Hubbard, Lucas, & Holmes, 1995). At the least, a backbone of cabling needs to be installed for computer networks, video, and telephones. While installing this backbone, make sure space is left in the conduit with fish strings, used to pull cable through the conduit, in place, so that new cables can be added as needed at a latter time (Hubbard, Lucas, & Holmes, 1995). It is best to plan in

advance for the use of technology in a school and to build flexibility into the infrastructure, than to retrofit buildings for the use of technology at a latter date.

For older schools, the buildings will have to be retrofitted so that new technologies can be used. This is much more expensive than planning for having future technologies easily added to a classroom (Hubbard, Lucas, & Holmes, 1995). Besides costing more, retrofitting can also take time, during which the educational technology can not be used. On Guam, Judy Woytowich (personal communication, July 8, 1999), a Christa McAulliffe Grant winner for 1997, has had computers sitting in boxes in her fourth grade classroom for over one year, because there was not enough electrical power at her school to run them. It may be another year before her classroom is rewired and the furniture is built so that her students can use the computers. It is important that the school's infrastructure can handle the technology, or it is upgraded, before the equipment is ordered so that the instructional technology program will not be delayed.

Communications. Teachers and administrators need to be able to receive and get information about the instructional technology program when one is implemented in a school. Communications is very important for the success of a program. Because technology is constantly changing, teachers need to use the Internet and e-mail to have access to resources and information (Heide & Henderson, 1994). By using the Internet and e-mail, teachers can form connections with other teachers, researchers at an universities, or other experts, which can provide them with help and needed information (Heide & Henderson, 1994). E-mail can also relieve some of the isolation teachers feel in the classroom by allowing them to share ideas and talk with other teachers (Fischer, Eisenhaur, et. al., 1998; Kao & Wedman, 1995). Communications channels should also be established so that both teachers and administrators can provide input, discuss issues, and monitor the progress of an instructional technology program (Kao & Wedman, 1995). It is important that communication channels be established early in the planning process and maintained for the lifetime of the project.

Program Support. Two kinds of support are needed for an instructional technology program, instructional and pedagogical (Meltzer & Sherman, 1998). Technical support is should

provide help in the physical setup and operation of the classroom (Heide & Henderson, 1994), equipment maintenance, and troubleshooting problems (Leggett & Persichitte, 1998). Teachers need pedagogical support, when using instructional technology, for the selection of appropriate instructional strategies, methods, and materials (Leggett & Persichitte, 1998), and for recommendations on how to integrated technology into their instruction (Meltzer & Sherman, 1998).

People that provide support need to be well versed in both technology and pedagogy (Meltzer & Sherman, 1998). One way to accomplish this is to form support teams. One member of the team would have expertise in the technology, while the other would be an expert in either the subject area or grade level (Kao & Wedman, 1995). Both team members would have to be able to work together and compliment each other's skills. They would also have to have regular training to keep up-to-date on both technological changes and pedagogical techniques (Roberts, 1998).

Support can be provided by personnel that are located either at the school site or the district office. At the district level, support is usually provided by a technology coordinator, technical maintenance person, web page (McDaniel & Umekubo, 1997), or a hot line to the support person (Niess & Merickel, 1997). The advantages of having support at the district level is that it is less expensive than hiring a support person for each school, the district support personnel are more likely to be better trained than the ones at the school level (Niess & Merickel, 1997), and teachers will depend less on a support person for solving all of their problems. By having teachers do minor troubleshooting, they will be encouraged to learn the technology (Kao & Wedman, 1995). The disadvantages to having support personnel located just at the district office are that the arrival of needed support may take too long, support may not be available when it is needed, and the support provided may not address the individual needs of a school (Niess & Merickel, 1997).

On-site support is usually provided by a technological knowledgeable teacher, aid, student, or a media specialist (Fulton, 1997; K. Lee, 1997; Fischer, Eisenhaur, et. al., 1998; Kao & Wedman, 1995). With support on-site, immediate needs of teachers can be addressed and problems can be fixed in a timely matter. One of the problems with on-site support is the person

providing it may no be as well trained as the district level support people. He or she may not be able to repair broken equipment, provide complete maintenance, or solve major problems (Niess & Merickel, 1997). Also, teachers may come to depend on the support person to solve all of their problems and never really learn how to use the technology by themselves (Kao & Wedman, 1995). The best solution for providing support would be to have both district and on-site support, but this is not always possible and hard choices have to be made based on the needs and resources of the program, the school and the school district.

Monitoring and Evaluation

For a technology program to succeed, there must be continuous monitoring during all phases of the program. Monitoring serves many important functions. Information about the program is made available to others through monitoring. This can provide other people with ideas and successful practices to help the current program and future ones succeed (Kao & Wedman, 1995). Monitoring a program can also encourage the development of promising practices or ideas, and the elimination of mistakes (Kao & Wedman, 1995). Monitoring also provides a way to assess progress and the changing needs of a program (Meltzer & Sherman, 1998). If problems arise, monitoring allows for the early detection of the problems and for the finding of possible solutions before these problems become serious. A procedure for monitoring the instructional technology program must be developed early in the planning stage and followed throughout the program's life.

Part of monitoring is also involved with evaluating the program, but evaluation is much more than what occurs during monitoring. Evaluation is a continuous process that is used to help make decisions about a program (Oliva, 1997). It is used to see if the goals and objectives of the program have been met. The evaluation process can help determine what needs to be improved in the program and to provide information that will help with the improvement process (Oliva, 1997). How a program is evaluated needs careful consideration and planning.

Most academic programs are evaluated by using a standardized achievement test. Standardized tests are not good measures of how technology affects the education of the students, or the skills and knowledge that they gain while using technology (Coley, Cradler, & Engel, 1997;

Dede, 1998) An evaluation method needs to be developed that can be used in addition to standardized testing. The evaluation of technology needs to look at the context in which the learning takes place. Computer skills, the ability to access information, and higher level thinking skills need to be evaluated in some way (Newton, 1997). The use of standardized tests should not be eliminated in the evaluation program, bu the public needs to understand that they are not the only evaluation method that should be used with an instructional technology program. That is why it is important to have the community and parents involved during the implementation of a technology program, so that they can understand it goals, objectives, and methods used for evaluation.

Conclusion

To help to understand all the features of the model presented in this paper a diagram of the model is presented in Figure 1. Each component of the model is connected to each other to form a chain. Just like a chain, if one of the links is broken in an instructional technology program, it is likely to fail. All of the links of the chain are needed to ensure success. Components in the model also form a closed circle. This is to remind people that the implementation of technology into a school is a continuos process, and does not end once the technology has been installed in the classroom. Technology changes. The needs of the students, school, and community change. So, the instructional technology program must also change to meet these changes. The implementation and integration of technology in the classroom must be a continuous process that takes time.

Changes that will occur in a school because of the introduction of technology will take time (McDonald & Ingvarson, 1997). Meltzer and Sherman (1998) state that it can take up to six years to implement an instructional technology program. To have a program succeed, one must be persistent and patient (Butzin, 1997). Do not expect changes to occur overnight, but slowly changes in the school, teachers, and students will become apparent. It is my hope that with this paper will help these slow changes in education successfully occur as technology is introduced into a school.

Figure 1. A diagram of the different components in a model for the implemention of an instructional technology program into a school.

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